WHAT IS CLAIMED IS:

1. A composition of matter of the formula

$$[C_nH_L]R_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube having a length to diameter ratio of greater than 5 and a diameter of less than 0.5 micron,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of R is the same and is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O-SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide, and

Z is carboxylate or trifluoroacetate.

2. A composition of matter of the formula

$$[C_nH_L]R_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic fibril being substantially free of pyrolytically deposited carbon, the projection of the graphite layers on said fibrils extends for a distance of at least two fibril diameters,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of R is the same and is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O\text{-}SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide, and

Z is carboxylate or trifluoroacetate.

3. A composition of matter as claimed in claim 2, wherein said fibril comprises cylindrical graphitic sheets whose c-axes are substantially perpendicular to their cylindrical axis.

4. A composition of matter as claimed in claim 2, wherein the outer diameter of said fibrils is less than 0.1 micron.

5. A composition of matter of the formula

$$[C_nH_L]R_m$$

wherein the carbon atoms, C_n, are surface atoms of a fishbone fibril,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of R is the same and is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3,

$Si\{OR'\}_yR'_{3-y}$, $Si\{O\text{-}SiR'_2\}OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide, and

Z is carboxylate or trifluoroacetate.

6. A composition of matter of the formula

$$[C_nH_L\}R_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube having a length to diameter ratio of greater than 5 and a diameter of less than 0.5 micron,

n is an integer, L is a number less than 0.1n and m is a number less than 0.5n,

each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si\{OR'\}_yR'_{3-y}$, $Si\{O\text{-}SiR'_2\}OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R' is selected from alkyl, aryl, cycloalkyl, aralkyl, cycloaryl,

R" is a fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is carboxylate or trifluoroacetate,

and further provided that where each of R is an oxygen-containing group COOH is not present.

7. A composition of matter of the formula

$$[C_nH_L]R_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic fibril being substantially free of pyrolytically deposited carbon, the projection of the graphite layers on said fibrils extends for a distance of at least two fibril diameters,

n is an integer, L is a number less than 0.1n and m is a number less than 0.5n,

each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O-SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is a fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is a carboxylate or trifluoroacetate,

and further provided that where each of R is an oxygen-containing group COOH is not present.

8. A composition of matter as claimed in claim 7, wherein said fibril comprises cylindrical graphitic sheets whose c-axes are substantially perpendicular to their cylindrical axis.

9. A composition of matter as claimed in claim 7, wherein the outer diameter of said fibrils is less than 0.1 micron.

10. A composition of matter of the formula

$$[C_nH_L]R_m$$

wherein the carbon atoms, C_n, are surface atoms of a fishbone fibril,

n is an integer, L is a number less than 0.1n and m is a number less than 0.5n,

each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O\text{-}SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is a fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is a carboxylate or trifluoroacetate,

and further provided that where each of R is an oxygen-containing group COOH is not present.

11. A composition of matter of the formula

$$[C_nH_L]R_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube having a length to

diameter ratio of greater than 5 and a diameter of less than 0.5 micron,

n is an integer, L is a number less than 0.1n and m is a number less than 0.5n,

each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O-SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R' is selected from alkyl, aryl, cycloalkyl, aralkyl, cycloaryl,

R" is a fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is carboxylate or trifluoroacetate,

and further provided that each of R does not contain oxygen.

12. A composition of matter of the formula

$$[C_nH_L]R_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic fibril being substantially free of pyrolytically deposited carbon, the projection of the graphite layers on said fibrils extends for a distance of at least two fibril diameters,

n is an integer, L is a number less than 0.1n and m is a number less than 0.5n,

each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si\{OR'\}_yR'_{3-y}$, $Si\{O-SiR'_2\}OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is a fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is a carboxylate or trifluoroacetate,

and further provided that each of R does not contain oxygen.

13. A composition of matter as claimed in claim 12, wherein said fibril comprises cylindrical graphitic sheets whose c-axes are substantially perpendicular to their cylindrical axis.

14. A composition of matter as claimed in claim 12, wherein the outer diameter of said fibrils is less than 0.1 micron.

15. A composition of matter of the formula

$$[C_nH_L]R_m$$

wherein the carbon atoms, C_n, are surface atoms of a fishbone fibril,

n is an integer, L is a number less than 0.1n and m is a number less than 0.5n,

each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si\{OR'\}_yR'_{3-y}$, $Si\{O\text{-}SiR'_2\}OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is a fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is a carboxylate or trifluoroacetate,

and further provided that each of R does not contain oxygen.

16. A composition of matter of the formula

$$[C_nH_L]_m A_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube having a length to diameter ratio of greater than 5 and a diameter of less than 0.1 micron,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of A is selected from

OY, NHY, $\overset{O}{\overset{\|}{C}}$-OY, $\overset{O}{\overset{\|}{C}}$-NR'Y, $\overset{O}{\overset{\|}{C}}$-SY, $\overset{O}{\overset{\|}{C}}$-Y, $-CR'_2$-OY, N=Y, and C=Y,

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, a nucleotide, an oligonucleotide, an antigen, or an enzyme substrate, enzyme

inhibitor or the transition state analog of an enzyme substrate or is selected from R'-OH, R'-NH_2, R'SH, R'CHO, R'CN, R'X, $R'SiR'_3$, $R'Si(OR')_yR'_{3-y}$, $R'Si(O-SiR'_2)OR'$, R'-R", R'-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w$-R', $(C_3H_6O)_w$-R' and R',

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200.

17. A composition of matter of the formula

$$[C_nH_L]A_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic fibril being substantially free of pyrolytically deposited carbon, the projection of the graphite layers on said fibrils extends for a distance of at least two fibril diameters,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of A is selected from

OY, NHY, $\overset{O}{\overset{\|}{C}}$-OY, $\overset{O}{\overset{\|}{C}}$-NR'Y, $\overset{O}{\overset{\|}{C}}$-SY, $\overset{O}{\overset{\|}{C}}$-Y, $-CR'_2$-OY, N=Y, and C=Y,

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, a nucleotide, an

oligonucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from R'-OH, R'-NH_2, R'SH, R'CHO, R'CN, R'X, $R'SiR'_3$, $R'Si(OR')_yR'_{3-y}$, $R'Si(O-SiR'_2)OR'$, R'-R", R'-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w$-R', $(C_3H_6O)_w$-R' and R',

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200.

18. A composition of matter as claimed in claim 17, wherein said fibril comprises cylindrical graphitic sheets whose c-axes are substantially perpendicular to their cylindrical axis.

19. A composition of matter as claimed in claim 17, wherein the outer diameter of said fibrils is less than 0.1 micron.

20. A composition of matter of the formula

$$[C_nH_L]A_m$$

wherein the carbon atoms, C_n, are surface atoms of a fishbone fibril,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of A is selected from

OY, NHX, $\overset{O}{\overset{\|}{C}}$-OY, $\overset{O}{\overset{\|}{C}}$-NR'Y, $\overset{O}{\overset{\|}{C}}$-SY, $\overset{O}{\overset{\|}{C}}$-Y, $-CR'_2-OY$, N=Y, and C=Y,

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, a nucleotide, an oligonucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from R'-OH, $R'-NH_2$, R'SH, R'CHO, R'CN, R'X, $R'SiR'_3$, $R'Si(OR')_yR'_{3-y}$, $R'Si(O-SiR'_2)OR'$, R'-R", R'-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w-R'$, $(C_3H_6O)_w-R'$ and R',

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200.

21. A composition of matter of the formula

$$[C_nH_L]+[R'-R]_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube having a length to diameter ratio of greater than 5 and a diameter of less than 0.5 micron,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O-SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

X is a halide,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl, and

Z is carboxylate or trifluoroacetate.

22. A composition of matter of the formula

$$[C_nH_L][R'-R]_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic fibril being substantially free of pyrolytically deposited carbon, the projection of the graphite layers on said fibrils extends for a distance of at least two fibril diameters,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O-SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

X is a halide,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl, and

Z is carboxylate or trifluoroacetate.

23. A composition of matter as claimed in claim 22, wherein said fibril comprises cylindrical graphitic sheets whose c-axes are substantially perpendicular to their cylindrical axis.

24. A composition of matter as claimed in claim 22, wherein the outer diameter of said fibrils is less than 0.1 micron.

25. A composition of matter of the formula

$$[C_nH_L]+[R'-R]_m$$

wherein the carbon atoms, C_n, are surface atoms of a fishbone fibril,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O-SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

X is a halide,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl, and

Z is carboxylate or trifluoroacetate.

26. A composition of matter of the formula

$$[C_nH_L]-[R'-A]_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube having a length to diameter ratio of greater than 5 and a diameter of less than 0.5 micron,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of R′ is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

A is selected from

OY, NHY, $\overset{O}{\overset{\|}{C}}$-OY, $\overset{O}{\overset{\|}{C}}$-NR′Y, $\overset{O}{\overset{\|}{C}}$-SY, $\overset{O}{\overset{\|}{C}}$-Y, $-CR'_2-OY$, N=Y, and C=Y,

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, a nucleotide, an oligonucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from R′-OH, $R'-NH_2$, R′SH, R′CHO, R′CN, R′X, $R'SiR'_3$, $R'Si(OR')_yR'_{3-y}$, $R'Si(O-SiR'_2)OR'$, R′-R", R′-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w$-R′, $(C_3H_6O)_w$-R′ and R′,

y is an integer equal to or less than 3,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200.

27. A composition of matter of the formula

$$[C_nH_L]-[R'-A]_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic fibril being substantially free of pyrolytically deposited carbon, the projection of the graphite layers on said fibrils extends for a distance of at least two fibril diameters,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

A is selected from

OY, NHY, $\overset{O}{\overset{\|}{C}}$-OY, $\overset{O}{\overset{\|}{C}}$-NR'Y, $\overset{O}{\overset{\|}{C}}$-SY, $\overset{O}{\overset{\|}{C}}$-Y, $-CR'_2$-OY, N=Y, and C=Y,

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, a nucleotide, an oligonucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from R'-OH, $R'-NH_2$, R'SH, R'CHO, R'CN, R'X,

$R'SiR'_3$, $R'Si(OR')_yR'_{3-y}$, $R'Si(O-SiR'_2)OR'$, R'-R", R'-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w$-R', $(C_3H_6O)_w$-R' and R',

y is an integer equal to or less than 3,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200.

28. A composition of matter as claimed in claim 27, wherein said fibril comprises cylindrical graphitic sheets whose c-axes are substantially perpendicular to their cylindrical axis.

29. A composition of matter as claimed in claim 27, wherein the outer diameter of said fibrils is less than 0.1 micron.

30. A composition of matter of the formula

$$[C_nH_L]-[R'-A]_m$$

wherein the carbon atoms, C_n, are surface atoms of a fishbone fibril,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

A is selected from

$$OY,\ NHY,\ \overset{O}{\overset{\|}{C}}-OY,\ \overset{O}{\overset{\|}{C}}-NR'Y,\ \overset{O}{\overset{\|}{C}}-SY,\ \overset{O}{\overset{\|}{C}}-Y,\ -CR'_2-OY,\ N=Y,\ \text{and}\ C=Y,$$

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, a nucleotide, an oligonucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from R'-OH, R'-NH_2, R'SH, R'CHO, R'CN, R'X, $R'SiR'_3$, $R'Si(OR')_yR'_{3-y}$, $R'Si(O\text{-}SiR'_2)OR'$, R'-R", R'-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w$-R', $(C_3H_6O)_w$-R' and R',

y is an integer equal to or less than 3,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200.

31. A composition of matter of the formula

$$[C_nH_L][X'\text{-}R_a]_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube having a length to diameter ratio of greater than 5 and a diameter of less than 0.5 micron,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n, a is zero or an integer less than 10,

each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O\text{-}SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R′ is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

X is a halide,

X′ is a polynuclear aromatic, polyheteronuclear aromatic or metallopolyheteronuclear aromatic moiety,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl, and

Z is carboxylate or trifluoroacetate.

32. A composition of matter of the formula

$$[C_nH_L]+[X'-R_a]_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic fibril being substantially free of pyrolytically deposited carbon, the projection of the graphite layers on said fibrils extends for a distance of at least two fibril diameters,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n, a is zero or an integer less than 10,

each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR′, SR′, SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O-SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R′ is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

X is a halide,

X′ is a polynuclear aromatic, polyheteronuclear aromatic or metallopolyheternuclear aromatic moiety,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl, and

Z is carboxylate or trifluoroacetate.

33. A composition of matter as claimed in claim 32, wherein said fibril comprises cylindrical graphitic sheets whose c-axes are substantially perpendicular to their cylindrical axis.

34. A composition of matter as claimed in claim 32, wherein the outer diameter of said fibrils is less than 0.1 micron.

35. A composition of matter of the formula

$$[C_nH_L]+[X'-R_a]_m$$

wherein the carbon atoms, C_n, are surface atoms of a fishbone fibril,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n, a is zero or an integer less than 10,

each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O-SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

X is a halide,

X' is a polynuclear aromatic, polyheteronuclear aromatic or metallopolyheteronuclear aromatic moiety,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl, and

Z is carboxylate or trifluoroacetate.

36. A composition of matter of the formula

$$[C_nH_L]+[X'-A_a]_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube having a length to diameter ratio of greater than 5 and a diameter of less than 0.5 micron,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n, a is an integer less than 10,

each of A is selected from

$$OY,\ NHY,\ \overset{O}{\overset{\|}{C}}-OY,\ C-NR'Y,\ \overset{O}{\overset{\|}{C}}-SY,\ \overset{O}{\overset{\|}{C}}-Y,\ -CR'_2-OY,\ N=Y,\ \text{and}\ C=Y,$$

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, a nucleotide, an oligonucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from R'-OH, R'-NH_2, R'SH, R'CHO, R'CN, R'X, $R'SiR'_3$, $R'Si(OR')_yR'_{3-y}$, $R'Si(O-SiR'_2)OR'$, R'-R", R'-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w$-R', $(C_3H_6O)_w$-R' and R',

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

X′ is a polynuclear aromatic, polyheteronuclear aromatic or metallopolyheteronuclear aromatic moiety,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200.

37. A composition of matter of the formula

$$[C_nH_L]+[X'-A_a]_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic fibril being substantially free of pyrolytically deposited carbon, the projection of the graphite layers on said fibrils extends for a distance of at least two fibril diameters,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n, a is an integer less than 10,

each of A is selected from

$$OY,\ NHY,\ \overset{O}{\overset{\|}{C}}-OY,\ \overset{O}{\overset{\|}{C}}-NR'Y,\ \overset{O}{\overset{\|}{C}}-SY,\ \overset{O}{\overset{\|}{C}}-Y,\ -CR'_2-OY,\ N=Y,\ \text{and}\ C=Y,$$

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, a nucleotide, an oligonucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from R′-OH, R′-NH_2, R′SH, R′CHO, R′CN, R′X, $R'SiR'_3$, $R'Si(OR')_yR'_{3-y}$, $R'Si(O-SiR'_2)OR'$, R′-R", R′-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w$-R′, $(C_3H_6O)_w$-R′ and R′,

y is an integer equal to or less than 3,

R′ is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

X' is a polynuclear aromatic, polyheteronuclear aromatic or metallopolyheteronuclear aromatic moiety,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200.

38. A composition of matter as claimed in claim 37, wherein said fibril comprises cylindrical graphitic sheets whose c-axes are substantially perpendicular to their cylindrical axis.

39. A composition of matter as claimed in claim 37, wherein the outer diameter of said fibrils is less than 0.1 micron.

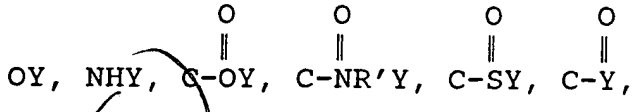
40. A composition of matter of the formula

$$[C_nH_L]+[X'-A_a]_m$$

wherein the carbon atoms, C_n, are surface atoms of a fishbone fibril,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n, a is an integer less than 10,

each of A is selected from



OY, NHY, C-OY, C-NR'Y, C-SY, C-Y, $-CR'_2-OY$, N=Y, and C=Y,

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, a nucleotide, an oligonucleotide, an antigen, or an enzyme substrate, enzyme

inhibitor or the transition state analog of an enzyme substrate or is selected from R'-OH, R'-NH_2, R'SH, R'CHO, R'CN, R'X, $R'SiR'_3$, $R'Si(OR')_yR'_{3-y}$, $R'Si(O-SiR'_2)OR'$, R'-R", R'-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w$-R', $(C_3H_6O)_w$-R' and R',

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

X' is a polynuclear aromatic, polyheteronuclear aromatic or metallopolyheternuclear aromatic moiety,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200.

41. A composition of matter as claimed in claims 31-40, wherein X' is a phthalocyanine or porphyrin.

42. A method of forming a composition of matter of the formula

$$[C_nH_L]R_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of R is the same and is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3,

$Si\{OR'\}_yR'_{3-y}$, $Si\{O-SiR'_2\}OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide, and

Z is carboxylate or trifluoroacetate,

comprising the step of reacting the surface carbons with an appropriate reagent under conditions sufficient to form functionalized nanotubes having the formula $[C_nH_L\}R_m$.

43. A method of forming a composition of matter of the formula

$$[C_nH_L\}R_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube,

n is an integer, L is a number less than 0.1n and m is a number less than 0.5n,

each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si\{OR'\}_yR'_{3-y}$, $Si\{O-SiR'_2\}OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R' is selected from alkyl, aryl, cycloalkyl, aralkyl, cycloaryl,

R" is a fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is carboxylate or trifluoroacetate,

and further provided that where each of R is an oxygen-containing group COOH is not present,

comprising the step of reacting the surface carbons with at least one appropriate reagent under conditions sufficient to form functionalized nanotubes having the formula $[C_nH_L]R_m$.

44. A method of forming a composition of matter of the formula

$$[C_nH_L]R_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube,

n is an integer, L is a number less than 0.1n and m is a number less than 0.5n,

each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O-SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R' is selected from alkyl, aryl, cycloalkyl, aralkyl, cycloaryl,

R" is a fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is carboxylate or trifluoroacetate,

and further provided that each of R does not contain oxygen,

comprising the step of reacting the surface carbons with at least one appropriate reagent under conditions sufficient to form functionalized nanotubes having the formula $[C_nH_L]R_m$.

45. A method of forming a composition of matter of the formula

$$[C_nH_L]A_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of A is selected from

OY, NHY, $\overset{O}{\overset{\|}{C}}$-OY, $\overset{O}{\overset{\|}{C}}$-NR'Y, $\overset{O}{\overset{\|}{C}}$-SY, $\overset{O}{\overset{\|}{C}}$-Y, $-CR'_2$-OY, N=Y, and C=Y,

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, an oligonucleotide, a nucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from R'-OH, R'-NH_2, R'SH, R'CHO, R'CN, R'X, R'SiR'_3, R'-R", R'-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w$-R', $(C_3H_6O)_w$-R' and R',

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200,

comprising the steps of:

(a) reacting the surface carbons with at least one appropriate reagent under conditions sufficient to form substituted nanotubes having the formula $[C_nH_L]R_m$, wherein each of R is the same and is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O\text{-}SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X, and y is an integer equal to or less than 3; and

(b) reacting the substituted nanotubes $[C_nH_L]R_m$ with at least one appropriate reagent under conditions sufficient to form functionalized nanotubes having the formula $[C_nH_L]A_m$.

46. A method of forming a composition of matter of the formula

$$[C_nH_L]\ A_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube having a length to diameter ratio of greater than 5 and a diameter of less than 0.1 micron,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of A is selected from

$$OY,\ NHY,\ \overset{O}{\overset{\|}{C}}-OY,\ \overset{O}{\overset{\|}{C}}-NR'Y,\ \overset{O}{\overset{\|}{C}}-SY,\ \overset{O}{\overset{\|}{C}}-Y,\ -CR'_2-OY,\ N=Y,\ \text{and}\ C=Y,$$

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, an oligonucleotide, a nucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from R'-OH, R'-NH_2, R'SH, R'CHO, R'CN, R'X, R'SiR'_3, R'-R", R'-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w$-R', $(C_3H_6O)_w$-R' and R',

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200,

comprising the steps of:

(a) reacting the surface carbons with at least one appropriate reagent under conditions sufficient to form substituted nanotubes having the formula $[C_nH_L]R_m$, wherein each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O-SiR'_2)OR'$,

R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X, and y is an integer equal to or less than 3; and

(b) reacting the substituted nanotubes $[C_nH_L]R_m$ with at least one appropriate reagent under conditions sufficient to form functionalized nanotubes having the formula $[C_nH_L]A_m$.

47. A method of forming a composition of matter of the formula

$$[C_nH_L] A_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube being substantially free of pyrolytically deposited carbon,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of A is selected from

OY, NHY, $\overset{O}{\overset{\|}{C}}$-OY, $\overset{O}{\overset{\|}{C}}$-NR'Y, $\overset{O}{\overset{\|}{C}}$-SY, $\overset{O}{\overset{\|}{C}}$-Y, $-CR'_2$-OY, N=Y, and C=Y,

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, an oligonucleotide, a nucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from R'-OH, $R'-NH_2$, R'SH, R'CHO, R'CN, R'X, $R'SiR'_3$,

R′-R", R′-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w$-R′, $(C_3H_6O)_w$-R′ and R′,

R′ is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200,

comprising the steps of:

(a) reacting the surface carbons with at least one appropriate reagent under conditions sufficient to form substituted nanotubes having the formula $[C_nH_L]R_m$, wherein each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR′, SR′, SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O-SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X, and y is an integer equal to or less than 3; and

(b) reacting the substituted nanotubes $[C_nH_L]R_m$ with at least one appropriate reagent under conditions sufficient to form functionalized nanotubes having the formula $[C_nH_L]A_m$.

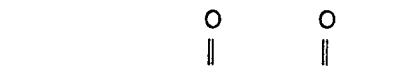
48. A method of forming a composition of matter of the formula

$$[C_nH_L] A_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of A is selected from



OY, NHY, C-OY, C-NR'Y, C-SY, C-Y, $-CR'_2-OY$, N=Y, and C=Y,

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, an oligonucleotide, a nucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from R'-OH, $R'-NH_2$, R'SH, R'CHO, R'CN, R'X, $R'SiR'_3$, R'-R", R'-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w-R'$, $(C_3H_6O)_w-R'$ and R',

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200,

comprising the step of reacting substituted nanotubes $[C_nH_L]R_m$ with at least one appropriate reagent under conditions sufficient to form functionalized nanotubes having the formula $[C_nH_L]A_m$, where each of R is the same and is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR',

SiR'_3, $Si\{OR'\}_yR'_{3-y}$, $Si\{O-SiR'_2\}OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X, and y is an integer equal to or less than 3.

49. A method of forming a composition of matter of the formula

$$[C_nH_L\} A_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube having a length to diameter ratio of greater than 5 and a diameter of less than 0.1 micron,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of A is selected from

OY, NHY, $\overset{O}{\overset{\|}{C}}$-OY, $\overset{O}{\overset{\|}{C}}$-NR'Y, $\overset{O}{\overset{\|}{C}}$-SY, $\overset{O}{\overset{\|}{C}}$-Y, $-CR'_2$-OY, N=Y, and C=Y,

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, an oligonucleotide, a nucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from R'-OH, $R'-NH_2$, R'SH, R'CHO, R'CN, R'X, $R'SiR'_3$, R'-R", R'-N-CO, $(C_2H_4O\}_wH$, $\{C_3H_6O\}_wH$, $\{C_2H_4O)_w$-R', $(C_3H_6O)_w$-R' and R',

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200,

comprising the step of reacting substituted nanotubes $[C_nH_L\}R_m$ with at least one appropriate reagent under conditions sufficient to form functionalized nanotubes having the formula $[C_nH_L\}A_m$, where each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si\{OR'\}_yR'_{3-y}$, $Si\{O-SiR'_2\}OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X, and y is an integer equal to or less than 3.

50. A method of forming a composition of matter of the formula

$$[C_nH_L\} A_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube being substantially free of pyrolytically deposited carbon,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of A is selected from

$$OY,\ NHY,\ \overset{O}{\overset{\|}{C}}-OY,\ \overset{O}{\overset{\|}{C}}-NR'Y,\ \overset{O}{\overset{\|}{C}}-SY,\ \overset{O}{\overset{\|}{C}}-Y,\ -CR'_2-OY,\ N=Y,\ \text{and}\ C=Y,$$

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, an oligonucleotide, a nucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is

selected from R′-OH, R′-NH_2, R′SH, R′CHO, R′CN, R′X, R′SiR'_3, R′-R", R′-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w$-R′, $(C_3H_6O)_w$-R′ and R′,

R′ is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200,

comprising the step of reacting substituted nanotubes $[C_nH_L]R_m$ with at least one appropriate reagent under conditions sufficient to form functionalized nanotubes having the formula $[C_nH_L]A_m$, where each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR′, SR′, SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O-SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X, and y is an integer equal to or less than 3.

51. A method of forming a composition of matter of the formula

$$[C_nH_L][R'-R]_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si\{OR'\}_yR'_{3-y}$, $Si\{O-SiR'_2\}OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

X is a halide,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl, and

Z is carboxylate or trifluoroacetate,

comprising the steps of:

(a) deoxygenating the graphitic nanotubes under conditions sufficient to form deoxygenated nanotubes; and

(b) reacting the deoxygenated nanotubes with at least one appropriate activated olefin under conditions sufficient to form functionalized nanotubes having the formula $[C_nH_L\}[R'-R]_m$.

52. A method of forming a composition of matter of the formula

$$[C_nH_L\}[R'-A]_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

X is a halide,

each of A is selected from

$$OY,\ NHY,\ \overset{O}{\overset{\|}{C}}\text{-}OY,\ \overset{O}{\overset{\|}{C}}\text{-}NR'Y,\ \overset{O}{\overset{\|}{C}}\text{-}SY,\ \overset{O}{\overset{\|}{C}}\text{-}Y,\ -CR'_2\text{-}OY,\ N{=}Y,\ \text{and}\ C{=}Y,$$

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, an oligonucleotide, a nucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from R'-OH, R'-NH_2, R'SH, R'CHO, R'CN, R'X, R'SiR'_3, R'-R", R'-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w$-R', $(C_3H_6O)_w$-R' and R',

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl, and

Z is carboxylate or trifluoroacetate,

comprising the steps of:

(a) deoxygenating the graphitic nanotubes under conditions sufficient to form deoxygenated nanotubes;

(b) reacting the deoxygenated nanotubes with at least one appropriate activated olefin to form substituted nanotubes having the formula $[C_nH_L]$-$[R'\text{-}R]_m$, where each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si(OR')_yR'_{3-y}$,

$Si\{O\text{-}SiR'_2\}_yOR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X, and y is an integer equal to or less than 3; and

(c) reacting the substituted nanotubes having the formula $[C_nH_L]\{R'\text{-}R\}_m$ with at least one appropriate reagent under conditions sufficient to form functionalized nanotubes having the formula $[C_nH_L]\{R'\text{-}A\}_m$.

53. A method of forming a composition of matter of the formula

$$[C_nH_L]\{R'\text{-}A\}_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

X is a halide,

each of A is selected from

OY, NHY, $\overset{O}{\overset{\|}{C}}$-OY, $\overset{O}{\overset{\|}{C}}$-NR'Y, $\overset{O}{\overset{\|}{C}}$-SY, $\overset{O}{\overset{\|}{C}}$-Y, $-CR'_2$-OY, N=Y, and C=Y,

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, an oligonucleotide, a nucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from R'-OH, $R'\text{-}NH_2$, R'SH, R'CHO, R'CN, R'X, $R'SiR'_3$,

R′-R", R′-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w$-R′, $(C_3H_6O)_w$-R′ and R′,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl, and

Z is carboxylate or trifluoroacetate,

comprising the step of reacting substituted nanotubes having the formula $[C_nH_L]-[R'-R]_m$ with at least one appropriate reagent under conditions sufficient to form functionalized nanotubes having the formula $[C_nH_L]-[R'-A]_m$, where each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR′, SR′, SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O-SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X, and y is an integer equal to or less than 3.

54. A method of forming a composition of matter of the formula

$$[C_nH_L]-[X'-R_a]_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n, a is zero or an integer less than 10,

each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR′, SR′, SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O-SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

R′ is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

X is a halide,

X′ is a polynuclear aromatic, polyheteronuclear aromatic or metallopolyheteronuclear aromatic moiety,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl, and

Z is carboxylate or trifluoroacetate,

comprising the step of adsorbing at least one appropriate macrocyclic compound onto the surface of the graphitic nanotube under conditions sufficient to form a functionalized nanotube having the formula $[C_nH_L]+[X'-R_a]_m$.

55. A method of forming a composition of matter of the formula

$$[C_nH_L]+[X'-A_a]_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n, a is an integer less than 10,

each of A is selected from

$$OY,\ NHY,\ \overset{O}{\overset{\|}{C}}-OY,\ \overset{O}{\overset{\|}{C}}-NR'Y,\ \overset{O}{\overset{\|}{C}}-SY,\ \overset{O}{\overset{\|}{C}}-Y,\ -CR'_2-OY,\ N=Y,\ \text{and}\ C=Y,$$

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, an oligonucleotide, a nucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from $R'-OH$, $R'-NH_2$, $R'SH$, $R'CHO$, $R'CN$, $R'X$, $R'SiR'_3$,

R′-R", R′-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w$-R′, $(C_3H_6O)_w$-R′ and R′,

R′ is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

X′ is a polynuclear aromatic, polyheteronuclear aromatic or metallopolyheteronuclear aromatic moiety,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200,

comprising the steps of:

(a) adsorbing at least one appropriate macrocyclic compound onto the surface of the graphitic nanotube under conditions sufficient to form a substituted nanotube having the formula $[C_nH_L]$-$[X'-R_a]_m$, where each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR′, SR′, SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O-SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X, and y is an integer equal to or less than 3; and

(b) reacting the substituted nanotubes $[C_nH_L]$-$[X'-R_a]_m$ with at least one appropriate reagent under conditions sufficient to form a functionalized nanotube having the formula $[C_nH_L]$-$[X'-A_a]_m$.

56. A method of forming a composition of matter of the formula

$$[C_nH_L\}[X'-A_a]_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube,

wherein n is an integer, L is a number less than 0.1n, m is a number less than 0.5n, a is an integer less than 10,

each of A is selected from

$$OY,\ NHY,\ \overset{O}{\overset{\|}{C}}-OY,\ \overset{O}{\overset{\|}{C}}-NR'Y,\ \overset{O}{\overset{\|}{C}}-SY,\ \overset{O}{\overset{\|}{C}}-Y,\ -CR'_2-OY,\ N=Y,\ \text{and}\ C=Y,$$

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, an oligonucleotide, a nucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from R'-OH, R'-NH_2, R'SH, R'CHO, R'CN, R'X, R'SiR'_3, R'-R", R'-N-CO, $(C_2H_4O\}_wH$, $\{C_3H_6O\}_wH$, $\{C_2H_4O)_w$-R', $(C_3H_6O)_w$-R' and R',

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

X' is a polynuclear aromatic, polyheteronuclear aromatic or metallopolyheteronuclear aromatic moiety,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200,

comprising the step of reacting the substituted nanotubes $[C_nH_L\}[X'-R_a]_m$ with at least one appropriate reagent

under conditions sufficient to form a functionalized nanotube having the formula $[C_nH_L]$-$[X'-A_a]_m$, where each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O-SiR'_2)OR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X, and y is an integer equal to or less than 3.

57. A method as recited in claims 54 or 55, wherein prior to the step of adsorbing onto the surface carbons, the graphitic nanotubes are dispersed in a medium.

58. A method as recited in claims 42, 43, 44, 45, 46 or 47, wherein prior to the step of reacting the surface carbons, the graphitic nanotubes are dispersed in a medium.

59. A method as recited in claims 45, 46, 47, 48, 49, 50, 52, 53, 55 or 56, wherein prior to the step of reacting the substituted nanotubes with the reagent, the substituted nanotubes are dispersed in a medium.

60. A method as recited in claims 42, 43, 44, 45, 46 or 47, wherein the step of reacting the surface carbons comprises sulfonating the surface carbons.

61. A method as recited in claims 42, 43, 44, 45, 46, 47, 48, 49 or 50, wherein the step of reacting the surface carbons comprises metallizing the surface carbons with an organometallic reagent.

62. The method as recited in claims 47 or 50, wherein the projection of the graphite layers on said nanotubes extends for a distance of at least two nanotube diameters.

63. The method as recited in claims 47 or 50, wherein said nanotube comprises cylindrical graphitic sheets whose c-axes are substantially perpendicular to their cylindrical axis.

64. The method as recited in claims 47 or 50, wherein the outer diameter of said nanotubes is less than 0.1. micron.

65. The method as recited in claims 47 or 50, wherein the carbon atoms, C_n, are surface atoms of a fishbone fibril.

66. A method of introducing functional groups onto the surface of carbon nanotubes to form a functionalized nanotube having the formula

$$[C_nH_L]+ A_m$$

wherein the carbon atoms, C_n, are surface carbons of a substantially cylindrical, graphitic nanotube being substantially free of pyrolytically deposited carbon,

n is an integer, L is a number less than 0.1n, m is a number less than 0.5n,

each of A is selected from

$$OY,\ NHY,\ \overset{O}{\overset{\|}{C}}\text{-}OY,\ \overset{O}{\overset{\|}{C}}\text{-}NR'Y,\ \overset{O}{\overset{\|}{C}}\text{-}SY,\ \overset{O}{\overset{\|}{C}}\text{-}Y,\ -CR'_2\text{-}OY,\ N{=}Y,\ \text{and}\ C{=}Y,$$

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, an oligonucleotide, a nucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from R'-OH, R'-NH_2, R'SH, R'CHO, R'CN, R'X, R'SiR'_3,

R′-R", R′-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w$-R′, $(C_3H_6O)_w$-R′ and R′,

R′ is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200,

comprising the steps of:

(a) contacting the carbon fibrils with oxidizing agents selected from the group including a solution of an alkali metal chlorate in a strong acid for a period of time sufficient to oxidize the surface of said fibrils; and

(b) contacting the surface-oxidized carbon fibrils with reactant suitable for adding a functional group to the surface of the carbon fibrils.

67. A method as recited in claim 66, wherein the carbon fibrils are subjected to processing prior to contact with the oxidizing agents.

68. A method as recited in claim 66, wherein the processing comprises dispersing the carbon fibrils in a solvent.

69. A method as recited in claim 68, wherein after being dispersed in the solvent the carbon fibrils are filtered and dried.

70. A method as recited in claim 66, wherein the alkali metal chlorate is sodium chlorate or potassium chlorate.

71. A method as recited in claim 66, wherein the strong acid is sulfuric acid.

72. A method as recited in claim 66, wherein the functional group added to the surface-oxidized fibrils is alkyl/aryl silane.

73. A method as recited in claim 66, wherein the functional group added to the surface-oxidized fibrils is a long chain alkyl/aralkyl group.

74. A method as recited in claim 66, wherein the functional group added to the surface-oxidized fibrils is a long chain hydroxyl group.

75. A method as recited in claim 66, wherein the functional group added to the surface-oxidized fibrils is a long chain amine group.

76. A method as recited in claim 66, wherein the functional group added to the surface-oxidized fibrils is a fluorocarbon.

77. A method as recited in claim 66, wherein the time sufficient for oxidization is between about 0.5 hour and 24 hours.

78. A network of functionalized fibrils comprising at least two functionalized fibrils linked at functional groups by either one or more direct bonds or at least one linker moiety, wherein said linker moiety is either bifunctional or polyfunctional.

79. A composition of matter of the formula

$$[F.F.]_n\text{linker}_m[F.F.]$$

wherein the linker is a bifunctional or polyfunctional moiety linked to an appropriate functionalized fibril, [F.F.], derived from the following substituted fibrils:

(i) $[C_nH_L]R_m$;

(ii) $[C_nH_L]R_m$;

(iii) $[C_nH_L]A_m$;

(iv) $[C_nH_L][R'-R]_m$;

(v) $[C_nH_L][R'-A]_m$;

(vi) $[C_nH_L][X'-R_a]_m$; and

(vii) $[C_nH_L][X'-A_a]_m$;

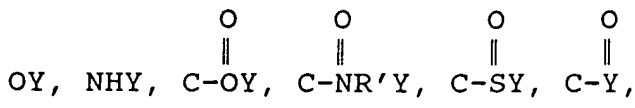
where the carbon atoms, C_n, are surface carbons of a graphitic nanotube,

n is an integer, L is a number less than 0.1n and m is a number less than 0.5n, a is zero or an integer less than 10,

each of R is selected from SO_3H, COOH, NH_2, OH, CHO, CN, COCl, halide, COSH, SH, COOR', SR', SiR'_3, $Si(OR')_yR'_{3-y}$, $Si(O-SiR'_2)_nOR'$, R", Li, AlR'_2, Hg-X, TlZ_2 and Mg-X,

y is an integer equal to or less than 3,

A is selected from



OY, NHY, C-OY, C-NR'Y, C-SY, C-Y, $-CR'_2-OY$, N=Y, and C=Y,

Y is an appropriate functional group of a protein, a peptide, an enzyme, an antibody, an oligonucleotide, a nucleotide, an antigen, or an enzyme substrate, enzyme inhibitor or the transition state analog of an enzyme substrate or is selected from R'-OH, $R'-NH_2$, R'SH, R'CHO, R'CN, R'X, $R'SiR'_3$, R'-R", R'-N-CO, $(C_2H_4O)_wH$, $(C_3H_6O)_wH$, $(C_2H_4O)_w-R'$, $(C_3H_6O)_w-R'$ and R',

R' is alkyl, aryl, cycloalkyl, aralkyl or cycloaryl,

R" is fluoroalkyl, fluoroaryl, fluorocycloalkyl or fluoroaralkyl,

X is a halide,

X' is a polynuclear aromatic, polyheteronuclear aromatic or metallopolyheteronuclear aromatic moiety,

Z is carboxylate or trifluoroacetate, and

w is an integer greater than one and less than 200.

80. A method for producing a network of carbon fibrils comprising contacting carbon fibrils with a strong oxidizing agent for a period of time sufficient to oxidize the surface of said carbon fibrils; contacting said surface-oxidized fibrils with reactant suitable for adding a functional group to the surface of the carbon fibrils; and further contacting said

surface-functionalized fibrils with an amount of a cross-linking agent effective for producing a network of carbon fibrils.

81. A method for producing a network of carbon fibrils comprising the steps of:

(a) contacting the fibrils with a solution of an alkali metal chlorate in a strong acid for a period of time sufficient to oxidize the surface of said fibrils;

(b) contacting the surface-oxidized fibrils with a reactant suitable for adding a functional group to the surface of the carbon fibrils; and

(c) further contacting said functionalized fibrils with an effective amount of a cross-linking agent.

82. A method as recited in claims 81 or 82, wherein the cross-linking agent is a diol or diamine.

83. A method for producing a network of carbon fibrils comprising contacting carbon fibrils with a strong oxidizing agent for a period of time sufficient to oxidize the surface of said carbon fibrils and contacting said surface-oxidized fibrils with an amount of a cross-linking agent effective for producing a network of carbon fibrils.

84. A method as recited in claim 83, wherein the strong oxidizing agent is an alkali metal chlorate or nitric acid.

85. A method as recited in claim 83, wherein the cross-linking agent is a polyol or polyamine.

86. A method for producing a network of functionalized fibrils comprising reacting at least two functionalized fibrils with a linker moiety comprising a bifunctional or polyfunctional moeity.

87. A surface-functionalized carbon fibril formed by the method comprising the steps of contacting carbon fibrils with an effective amount of a strong oxidizing agent for a period of time sufficient to oxidize the surface of said fibrils; and further contacting said fibrils with reactant suitable for adding a functional group to the surface of said fibrils.

88. A surface-modified carbon fibril comprising a carbon fibril whose surface is uniformly substituted with a functional group.

89. A surface-modified carbon fibril as claimed in claim 88, wherein the functional group is carboxyl.

90. A method of uniformly substituting the surface of carbon fibrils with a functional group comprising contacting carbon fibrils with an effective amount a of reactant capable of uniformly substituting a functional group onto the surface of said carbon fibrils.

91. A method of uniformly substituting the surface of carbon fibrils with a functional group as claimed in claim 90, wherein the functional group is carboxyl.

92. A method as recited in claim 90, wherein the reactant is a functionalized porphyrin.

93. A method as recited in claim 90, wherein the reactant is a phthalocyanine.

94. A method as recited in claim 93, wherein the phthalyocyanine is cobalt phthalocyanine.

95. A surface-modified carbon fibril made by the method comprising contacting carbon fibrils with an effective amount of a reactant for substituting a functional group onto the surface of said carbon fibrils.

96. A surface-modified carbon fibril as recited in claim 95, wherein the reactant is a functionalized porphyrin.

97. A surface-modified carbon fibril as recited in claim 96, wherein the reactant is a phthalocyanine.

98. A surface-modified carbon fibril as recited in claim 97, wherein the phthalocyanine is cobalt phthalocyanine.

99. A network of carbon fibrils formed by a method comprising the steps of:

(a) contacting carbon fibrils with an oxidizing agent for a period of time sufficient to oxidize the surface of said fibrils;

(b) contacting the surface-oxidized fibrils with reactant suitable for adding a functional group to the surface of the fibrils; and

(c) further contacting said surface-functionalized fibrils with an effective amount of a cross-linking agent.

100. An electrode comprising functionalized nanotubes.

101. An electrode as recited in claim 100, wherein the functionalized nanotubes is phthalocyanine substituted nanotubes.

102. A reinforced ceramic material comprising functionalized nanotubes dispersed in a ceramic matrix material.

103. A reinforced ceramic material produced by dispersing a functionalized nanotube in an aqueous solution containing a hydrolyzable precursor of the ceramic material and converting the hydrolyzable precursor to a reinforced ceramic material.

104. A method of making a reinforced ceramic material comprising dispersing a functionalized nanotube in an aqueous solution containing a hydrolyzable precursor of a ceramic matrix material and converting the hydrolyzable precursor to a reinforced ceramic material.

105. A sol gel material comprising the functionalized nanotubes.

106. A porous material comprising a multiplicity of functionalized nanotube networks as defined in claims 78 or 79.

107. An adsorbent material comprising the porous material of claim 103.

108. A catalyst support material comprising the porous material of claim 103.

109. A chromatography media material comprising the porous material of claim 103.